

Name \_\_\_\_\_ Date \_\_\_\_\_ Block \_\_\_\_\_

Note-taker: Zero & Negative Exponents

$2^3 = 8$

$2^2 = 4$

$2^1 = 2$

$2^0 = 1$

$2^{-1} = \frac{1}{2}$

$2^{-2} = \frac{1}{4}$

$2^{-3} = \frac{1}{8}$

Definition of Zero and Negative Exponents

➔ Any non-zero number to the power of zero ( $a^0$ ) equals 1.

➔  $a^{-n}$  is the reciprocal of  $a^n$ .  $a^{-n} = \frac{1}{a^n}$

➔ Zero raised to power greater than 0 is 0.  
Zero raised to a power less than 1 is undefined.

$$0^4 \quad 0^{-2} \rightarrow \frac{1}{0^2}$$

Example 1:

Powers with Zero and Negative Exponents

Simplify.

<u>Together</u>	<u>On Your Own</u>
1. $2^{-2} = \frac{1}{2^2} = \frac{1}{4}$	6. $3^{-4} = \frac{1}{3^4} = \frac{1}{81}$
2. $(-2)^0 = 1$	7. $(-5.2)^0 = 1$
3. $5^{-x} = \frac{1}{5^x}$	8. $4^{-y} = \frac{1}{4^y}$
4. $\left(\frac{1}{3}\right)^{-1} = 3$	9. $\left(\frac{3}{5}\right)^{-1} = \frac{5}{3}$
5. $0^{-3} = \text{undefined}$	10. $0^{-1} = \text{undefined}$

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$2^{-2} = \frac{1}{2^2}$

$2^{-3} = \frac{1}{2^3}$

$x^0 = 1$

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➔  $a^{-n}$  is the reciprocal of  $a^n$ .  $a^{-n} = \frac{1}{a^n}$

➔ Zero raised to power greater than 0 is \_\_\_\_.  
Zero raised to a power less than 1 is \_\_\_\_.

Example 1:

Powers with Zero and Negative ExponentsSimplify.

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Note-taker: Division Properties of Exponents

$$\frac{4^5}{4^3} = \frac{4 \cdot 4 \cdot \cancel{4} \cdot \cancel{4} \cdot \cancel{4}}{\cancel{4} \cdot \cancel{4} \cdot \cancel{4}} = 4 \cdot 4 = 4^{5-3} = 4^2 = 16$$

**Division Properties of Exponents**Let  $a$  and  $b$  be numbers and let  $m$  and  $n$  be integers.Quotient of Powers Property

$$\frac{a^m}{a^n} = a^{m-n}$$

$$\frac{3^7}{3^5} = 3^{7-5} = 3^2 = 9$$

To divide powers having the same base, subtract the exponents.\* Power of a Quotient Property \*

$$\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$$

$$\left(\frac{4}{5}\right)^3 = \frac{4^3}{5^3} = \frac{64}{125}$$

To find a power of a quotient, find the power of the numerator and the power of the denominator and simplify.

Example 1:

Quotient of Powers

Simplify.

Together

1.  $\frac{6^5}{6^4} = 6^{5-4} = 6$

2.  $\frac{(-5)^2}{(-5)^2} = (-5)^{2-2} = (-5)^0 = 1$

3.  $\frac{9^4 \cdot 9^2}{9^7} = \frac{9^6}{9^7} = 9^{-1} = \frac{1}{9}$

4.  $\frac{8^2 \cdot 8^4}{8^9} = \frac{8^6}{8^9} = 8^{-3} = \frac{1}{8^3} = \frac{1}{216}$

5.  $\frac{1}{y^5} \cdot y^3 = \frac{y^3}{y^5} = y^{3-5} = y^{-2} = \frac{1}{y^2}$

6.  $z^7 \cdot \frac{1}{z^8} = \frac{z^7}{z^8} = z^{7-8} = z^{-1} = \frac{1}{z}$

On Your Own

7.  $\frac{4^5}{4^2} =$

8.  $\frac{(-3)^4}{(-3)^4} =$

9.  $\frac{6^3 \cdot 6^5}{6^9} =$

$$10. \frac{2}{x^4} \cdot x^2 =$$

$$11. \frac{3^2}{3^3} =$$

$$12. y^8 \cdot \frac{1}{y^2} =$$

Pugliese, 2007-2008

Example 2:

Power of a Quotient

Simplify.

Together

$$1. \left(\frac{2}{3}\right)^2 = \frac{2^2}{3^2} = \frac{4}{9}$$

$$2. \left(-\frac{3}{y}\right)^3 = \frac{(-3)^3}{y^3} = \frac{-27}{y^3}$$

$$3. \left(\frac{7}{4}\right)^{-3} = \left(\frac{4}{7}\right)^3 = \frac{64}{343}$$

$$\begin{aligned} * 4. \left(\frac{-6x^2y}{2xy^3}\right)^3 &= \frac{(-6)^3 x^6 y^3}{(2)^3 x^3 y^9} \\ &= \frac{-216 x^6 y^3}{8 x^3 y^9} \end{aligned}$$

On Your Own

$$5. \left(\frac{1}{4}\right)^3 =$$

$$\begin{aligned} 6. -\left(\frac{4}{x}\right)^2 &= -27x^3y^{-6} \\ &= \frac{-27x^3}{y^6} \end{aligned}$$

$$7. \left(\frac{3}{2}\right)^{-4} =$$

$$8. \left(\frac{2x^3y^4}{3xy}\right)^3 =$$